

The influence of roughness in hindering the spread of liquid over the surface of the impinging sphere is then pointed out.

At the close of the paper an explanation is put forward of the radial ribs, arms, and striæ which are a notable feature of all splashes. Measurements of the annular rim bordering a thin central film, into which a drop falling upon a plate passes,* show that the number of the lobes and arms which are subsequently observed, agrees well with the number of drops into which such an annulus would theoretically tend to split if unhindered by friction with the plate on which it rests, and it is then pointed out that the effect of the connecting film would be exactly such as to counteract the influence of this friction.

In the same way the radial striæ and ribs which characterise the hollow formed round a drop or solid sphere impinging on a liquid surface, are accounted for by the instability of the annular rim of the hollow, which through its tendency to cleave into a definite number of drops, determines a corresponding number of lines of easiest flow, at each of which a rib or arm is developed.

The author has observed that after the details have been once revealed by the method of instantaneous illumination, it is not difficult to identify the broad features of any splash that may occur by attentive observation in continuous light. Such observation may afford valuable information as to the condition of the surface of an impinging solid.

II. "The Minute Anatomy of the Thymus." By HERBERT WATNEY, M.A., M.D. Cantab. Communicated by E. A. SCHÄFER, F.R.S. Received January 30, 1882.

(Abstract.)

Three short notes relating some of the facts mentioned in this research have been published in the "Proceedings," vol. 27, p. 369; vol. 31, p. 326, and vol. 33, p. 11.

The paper begins with a history of the views which have been held as to the anatomy, physiology, and development of the thymus.

The microscopical sections in many instances were double-stained by hæmatoxylin, by using first a red and then a blue solution; the colours of the solutions depend on the alum used with the hæmatoxylin extract. The red solutions stain the protoplasm of the cells, the connective-tissue, and the granular cells; the blue, the lymphoid corpuscles and the reticulum.

In all mammals the thymus disappears at some period of adult life;

* "Proc. Roy. Soc.," vol. 25, p. 500, fig. 4.

in the bird it disappears generally before adult life; in the reptile and the fish it is found even in very large specimens, although in such cases it is in great measure transformed into connective-tissue.

The fully developed gland is divided into lobes, lobules, and follicles; the follicles, except in earliest embryonic life, are composed of cortex and medulla; the follicles are generally attached to one another, either by cortical or by medullary tissue.

When first developed the thymus is composed at its upper end of a single tube, and below of a number of tubes, some of which are solid, the others hollow; the cells in cross section of the tube vary from two or three to many in number, and are epithelioid in character; the lumen of the tube is at times closely packed with blood-corpuscles, and appears to be a vessel. The follicle first grows by pushing out processes of epithelioid cells. In a subsequent stage the connective-tissue (ensheathing the vessels which enter and leave the follicles) invades the follicles and divides them up; at the same time the follicles increase in size: there is thus an increase in the number of the follicles, which are partially united to one another.

The cortex when first formed is small, but in the fully developed gland is more than twice as large as the medulla; in involution the outer part of the follicle disappears much the more rapidly of the two. As further the cortex is composed chiefly of cells (*thymic corpuscles*), similar to those which are formed in the lymphatics of the thymus, this portion is the more important.

The blood-vessels are disposed in two rings, one of which surrounds the follicle, the other lies just within the margin of the medulla; the cortex contains only fine vessels arranged in a radiating manner; the blood in these vessels flows chiefly to the inner circle of vessels. The centre of the medulla contains only few and fine vessels during growth and the period of full development, but in involution there are many more and larger vessels. The blood-vessels met with in the invading processes of connective-tissue during involution are surrounded by an adventitia of epithelioid cells, so that they look somewhat as if composed of proliferating endothelium; this probably is not the case, as their lumen is unaltered.

There are no lymphatic vessels in the cortex of the follicle, although perivascular sheaths are found on the vessels during the period of involution.

The cortex is composed in great measure of lymphoid cells, supported by a delicate *reticulum*. If sections of the cortex are shaken a second retiform tissue is brought into view, *i.e.*, a branched *network*, composed of finely branched cells, and of coarse threads; these together form an adventitia to the vessels. This network of cells is permanent, and is found in the thymus of adult animals when the organ is undergoing involution. In specimens stained in indigo-

carmine and carmine, the *network* is stained of a different colour to the *reticulum*.

The network of the cortex is continuous with a network in the medulla; in the latter situation, however, the cells are large and their processes are coarse. There is a gradual transition between these last and epithelioid connective-tissue corpuscles; and, further, in some places the network assumes the form of multi-nucleated protoplasmic masses not differentiated into cells. In the medulla but few lymphoid cells and only traces of the reticulum are seen, but it contains concentric corpuscles, giant cells, and numerous granular and epithelioid cells.

Granular cells are met with in the later period of embryonic life; they are not readily acted on by ordinary staining solutions; their protoplasm resembles that of the giant cells of the medulla of bone. They are present in four forms:—(1) As polygonal or rounded epithelioid cells, the central part only of the cells being granular; (2) as vacuolated cells, the mass lying in the vacuole being granular; (3) as spherical masses lying in cavities between the branching processes of the connective-tissue corpuscles; and (4) as rounded or club-shaped masses attached (often by fibrillated extremities) to blood-vessels and to newly formed connective-tissue. The first form arises from epithelioid connective-tissue corpuscles, and gives origin to the second and third varieties. The fourth variety forms fibrous tissue, and sometimes forms blood-vessels: the cells of this class are very similar in appearance to certain cells (*Bildungszellen*) which have been described by Ziegler and Tillmanns in pathological new formations.

The giant cells arise in two ways, either from the fusion of several granular cells, or from the branched protoplasmic network.

The concentric corpuscles consist of a central mass and of a capsule; the central mass is at times found passing down the vessel-like prolongations, which are attached to the concentric corpuscles; the capsule is formed of epithelioid cells; these cells are anatomically continuous with the branched connective-tissue corpuscles forming the network; the cells of the network around the concentric corpuscles are larger than in other parts of the medulla. The concentric corpuscles are attached to one another by long coarse threads which have nuclei imbedded in them, or by bands of fibrous tissue. They are finally transformed into bands of fibrous tissue containing vessels. The central part of the concentric corpuscles is never penetrated by injection, although the outer part of the capsule often contains vessels, as the capsule of epithelioid cells in its growth may surround a vessel. The smaller concentric corpuscles are composed of one or more granular cells, surrounded by epithelioid connective-tissue corpuscles; they arise from these two sources.

Ciliated epithelium is found lining cysts in the thymus of the dog.

The cysts are formed by the vacuolation and degeneration of the central cells of the small concentric corpuscles; they are filled with degenerated epithelium, or with hæmoglobin masses. The borders of the cysts are at first formed of epithelioid cells, but there is a gradual transition from these flattened cells to ciliated epithelium.

The process of involution is very gradual; the first steps are begun in foetal life. The main factors are :—(1) The formation of fibrous tissue within the follicle; this arises by means of the granular cells, of the giant cells, and of the connective-tissue corpuscles; (2) the increase in the inter-follicular connective-tissue, and the deposit of plasma cells in this tissue; the plasma cells are here the forerunners of fat cells; they are identical with many of the colourless cells of the medulla of bone, and stain in a very characteristic manner in indigo-carmin and carmine solutions; (3) the invasion of the inter-follicular connective-tissue and plasma cells into the follicle. There is no fatty degeneration of the cells of the thymus.

There is considerable difference in size between the *thymic corpuscles* and the colourless blood-corpuscles in amphibia and reptiles, and still greater difference in the bird and the fish. The differences between the thymus of birds, reptiles, and fishes, and that of mammals are also pointed out in the paper.

Hæmoglobin is found in the thymus contained either in cysts, or in cells which are situated near to, or form part of, the concentric corpuscles. The hæmoglobin in the cells varies from granules to masses exactly resembling coloured blood-corpuscles; these masses are oval in the bird, reptile, and fish, but circular in all mammals except the camel.

The lymph issuing from the thymus was obtained by tying the vessels; it contains more colourless cells than do the large lymphatics of the neck, and, in addition, contains cells inclosing hæmoglobin in the form of granules, or in masses resembling coloured blood-corpuscles.

The physiological conclusions arrived at are: that the thymus forms one source of colourless blood-corpuscles, and that the cells containing hæmoglobin masses form coloured blood-corpuscles. This view is supported by the inclosed masses being identical in form with, though often smaller in size than, the coloured blood-corpuscles; is further supported by finding such cells in the lymphatics, in the blood, in the lymphatic glands, the medulla of bone, and the spleen; and is still further supported by the development of the blood in the chick, and in the connective-tissue of young mammals.